FIG.1

50

100

1 2 1 3 1

CORRECTION OFFSET Δ

FIG.2

KrF

PATTERN DIMENSIONAL
FLUCTUATION COEFFICIENT
ON WAFER

1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00

0   5   10   15   20   25   30

CORRECTION OFFSET
TOLERABLE RANGE ON MASK
± 27.2 nm ON MASK

CORRECTION OFFSET (ON WAFER, nm)

FIG.3

ArF

PATTERN DIMENSIONAL
FLUCTUATION COEFFICIENT
ON WAFER

1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00

0   5   10   15   20   25   30

CORRECTION OFFSET (ON WAFER, nm)

CORRECTION OFFSET
TOLERABLE RANGE ON MASK
±16.6 mm ON MASK

FIG.4

CORRECTION OFFSET Δ

FIG.5

PATTERN DIMENSIONAL
FLUCTUATION COEFFICIENT
ON WAFER

CORRECTION OFFSET (ON WAFER, nm)

CORRECTION OFFSET
TOLERABLE RANGE ON MASK
±24.2 mm ON MASK
(SEMITRANSPARENT AREA)

FIG.6

PATTERN DIMENSIONAL
FLUCTUATION
COEFFICIENT ON WAFER

SHADING AREA WIDTH (ON WAFER, nm)

SHADING AREA WIDTH
FLUCTUATION TOLERABLE
RANGE ON MASK
±78.4 mm ON MASK
(SHADING AREA)

FIG.7

RATIO OF THE DIMENSIONAL FLUCTUATION IN PATTERN ON WAFER TO FLUCTUATION IN SEMITRANSPARENT AREA WIDTH
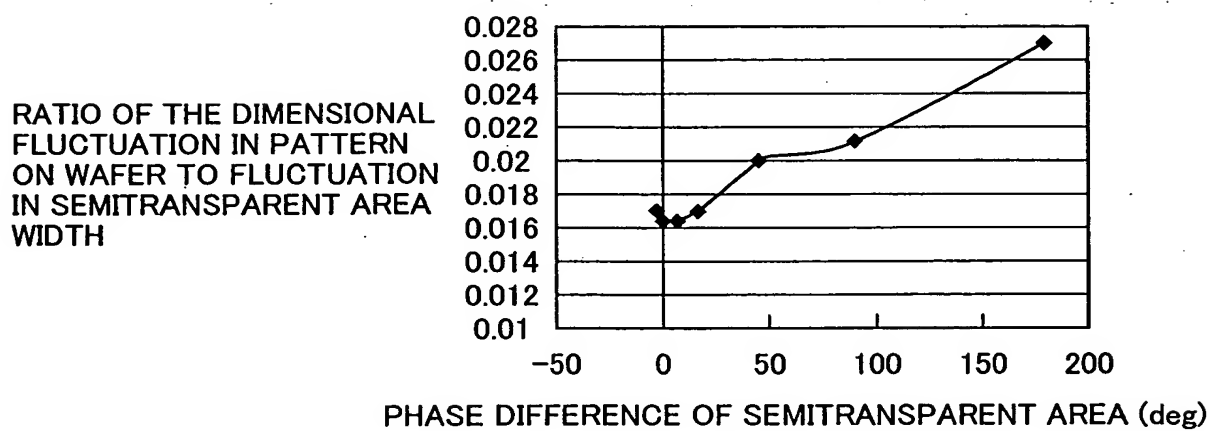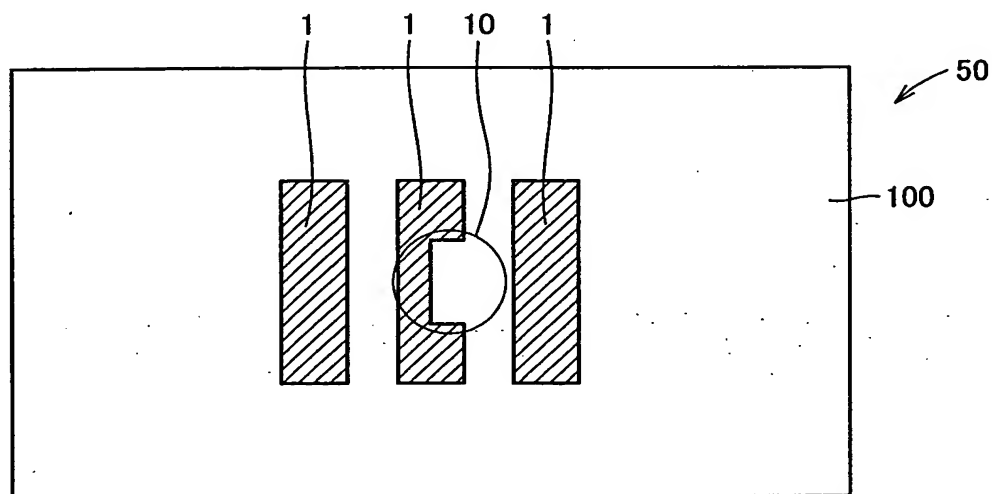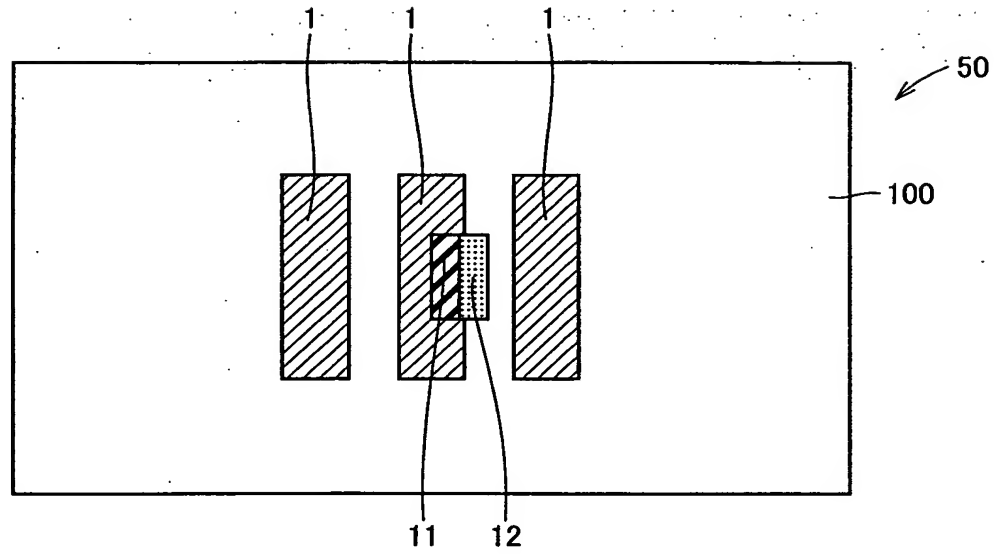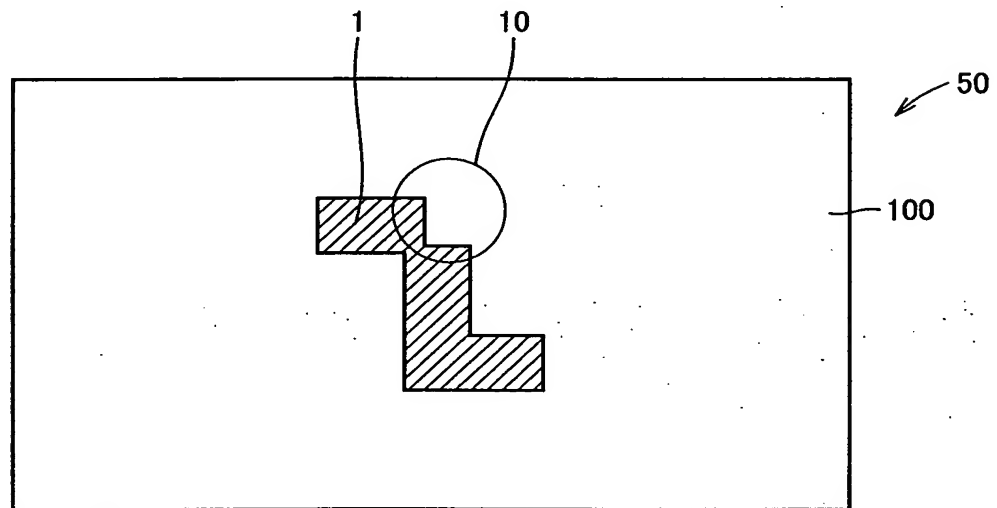

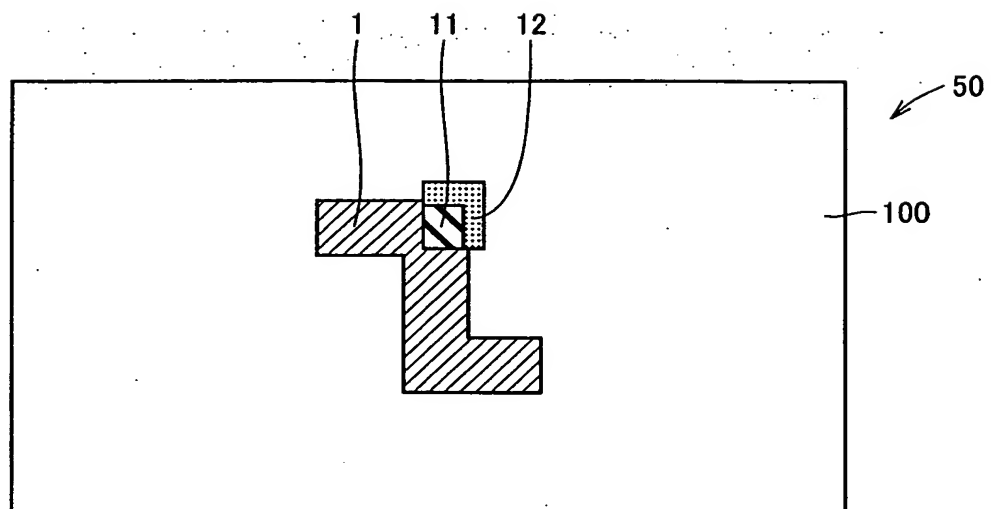PHASE DIFFERENCE OF SEMITRANSPARENT AREA (deg)

FIG.8

FIG.9

FIG.10

FIG.11

FIG.12

FIG.13

FIG.14

FIG.15

FIG.16

FIG.17

FIG.18

FIG.19

1 12 11

50

100

FIG.20

50

10

100

FIG.21

50

12   11

100

FIG.22

THIS Δ CONTROL IS PERFORMED IN SEMITRANSPARENT AREA IN THE PRESENT INVENTION

100 Δ=0   100   Δ1   3   100   Δ2   3

1   1

INTENSITY OF LIGHT

WHEN EDGE POSITION OF CARBON FILM IS THE SAME POSITION AS IMAGINARY EDGE, SPACE TRANSFERRED ONTO WAFER BECOMES BROAD

EDGE POSITION OF CARBON FILM IS SLIGHTLY PROJECTED FROM IMAGINARY PATTERN HAVING NO DEFECT.
NO DIMENSION FLUCTUATION IN PATTERN ON WAFER

FIG.23

METHOD OF COMPARATIVE EMBODIMENT

DIMENSION OF
HOLE PATTERN ON WATER
(nm)

0.2
0.15
0.1
0.05
0

defocus
(um)

offset
(ON WAFER, nm)

⊠ 0.15–0.2
☐ 0.1–0.15
⧄ 0.05–0.1
⧅ 0–0.05

FIG.24

METHOD OF THE PRESENT INVENTION

DIMENSION OF
HOLE PATTERN ON WATER
(nm)

0.2
0.15
0.1
0.05
0

defocus
(um)

offset
(ON WAFER, nm)

⊠ 0.15–0.2
☐ 0.1–0.15
⧄ 0.05–0.1
⧅ 0–0.05

FIG.25

DOSE AND TRANSMISSIVITY @ 193nm

Legend:
- □ No gas
- ▲ 0.5Torr
- ○ 1Torr
- ◆ 2Torr

TRANSMISSIVITY(%)

Dose(nC/μm^2)

FIG.26

DOSE AND ETCHING DEPTH

ETCHING DEPTH (nm)

```
300
250
200
150
100
 50
  0
-50
   0   0.2   0.4   0.6   0.8   1   1.2
```

DOSE(nC/μ m^2)

◆ No gas
■ 1 Torr

FIG.27

```
┌─────────────────────────┐ S1    ┌──────────────────────────────┐
│ SET PHOTOMASK TO         │┐      │ ADJUST ALIGNMENT OF FIB      │
│ CORRECTING APPARATUS     │├      └──────────────────────────────┘
└─────────────────────────┘│      ┌──────────────────────────────┐
           │                │      │ RESET COORDINATE SYSTEM      │
           ↓                ┘      └──────────────────────────────┘
┌─────────────────────────┐ S2
│ OBSERVE DEFECT PORTION   │┐      ┌──────────────────────────────┐
│ BY MASK OBSERVING DEVICE │├      │ INPUT DEFECT DATA FROM DEFECT│
│ IN CORRECTING APPARATUS  │┘      │ INSPECTING APPARATUS         │
└─────────────────────────┘       └──────────────────────────────┘
           │
           ↓                  S3
┌─────────────────────────┐┐      ┌──────────────────────────────┐
│ DETERMINE IMAGE AFTER    ││      │ SET POSITIONS WHERE SHADING  │
│ CORRECTION OF DEFECT     │├      │ AREA AND SEMITRANSPARENT     │
└─────────────────────────┘┘      │ AREAS ARE TO BE FORMED       │
           │                      └──────────────────────────────┘
           ↓                  S4
┌─────────────────────────┐┐      ┌──────────────────────────────┐
│ FORM SHADING AREA        │├      │ RADIATE FIB ONTO A PART OF   │
└─────────────────────────┘┘      │ DEFECT PORTION IN ORGANIC GAS│
           │                      │ ATMOSPHERE TO FORM CARBON FILM│
           ↓                  S5   └──────────────────────────────┘
┌─────────────────────────┐┐      ┌──────────────────────────────┐
│ FORM SEMITRANSPARENT     ││      │ FORM SEMITRANSPARENT AREAS IN│
│ AREA                     │├      │ AREAS ADJACENT TO CARBON FILM│
└─────────────────────────┘┘      │ IN ATMOSPHERE OF GAS FOR     │
           │                      │ BLOCKING QUARTZ SUBSTRATE ETCHING│
           ↓                  S6   └──────────────────────────────┘
┌─────────────────────────┐
│ UNLOAD PHOTOMASK FROM    │
│ CORRECTING APPARATUS     │
└─────────────────────────┘
```
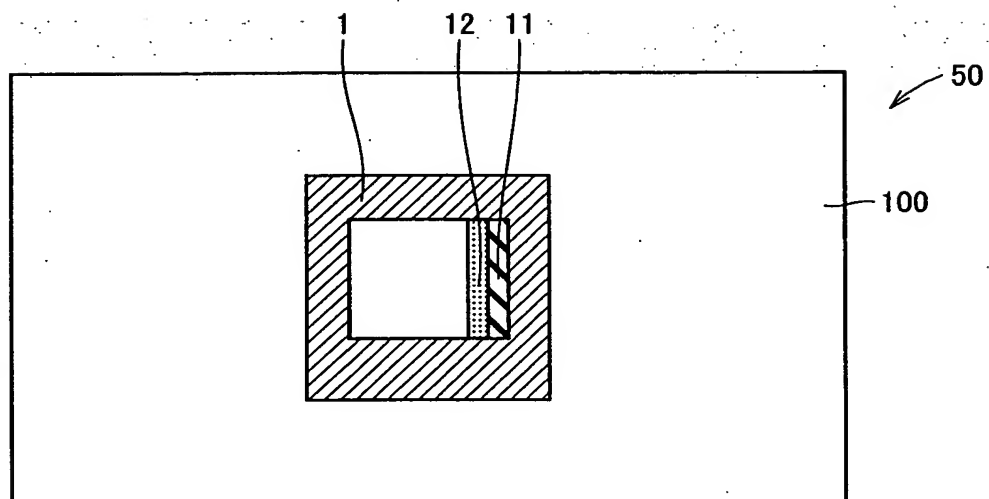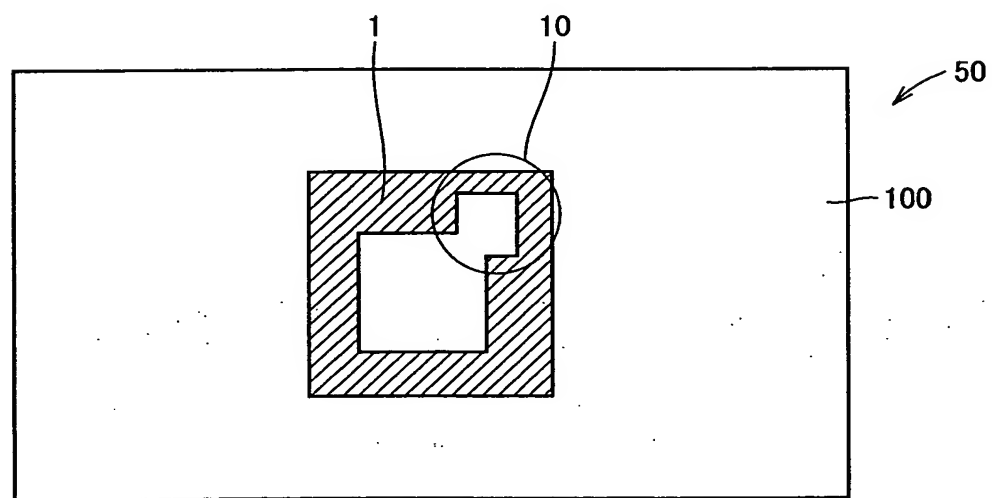
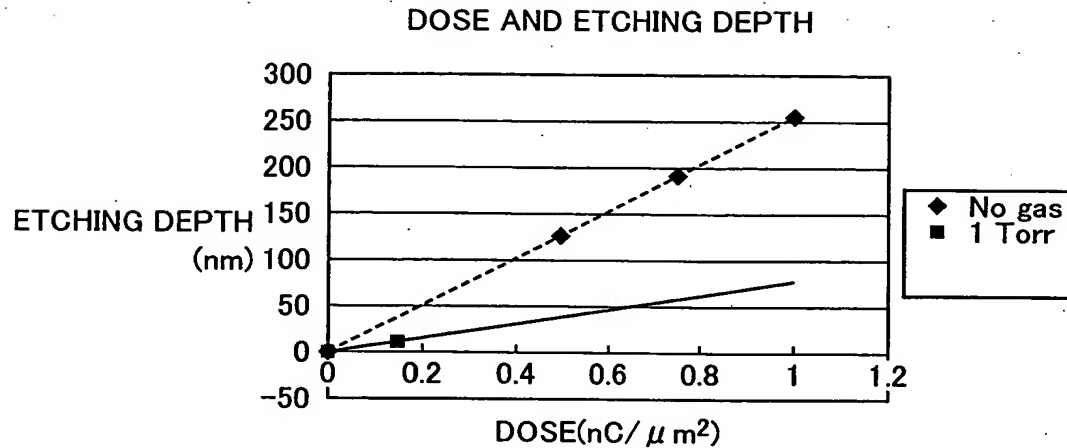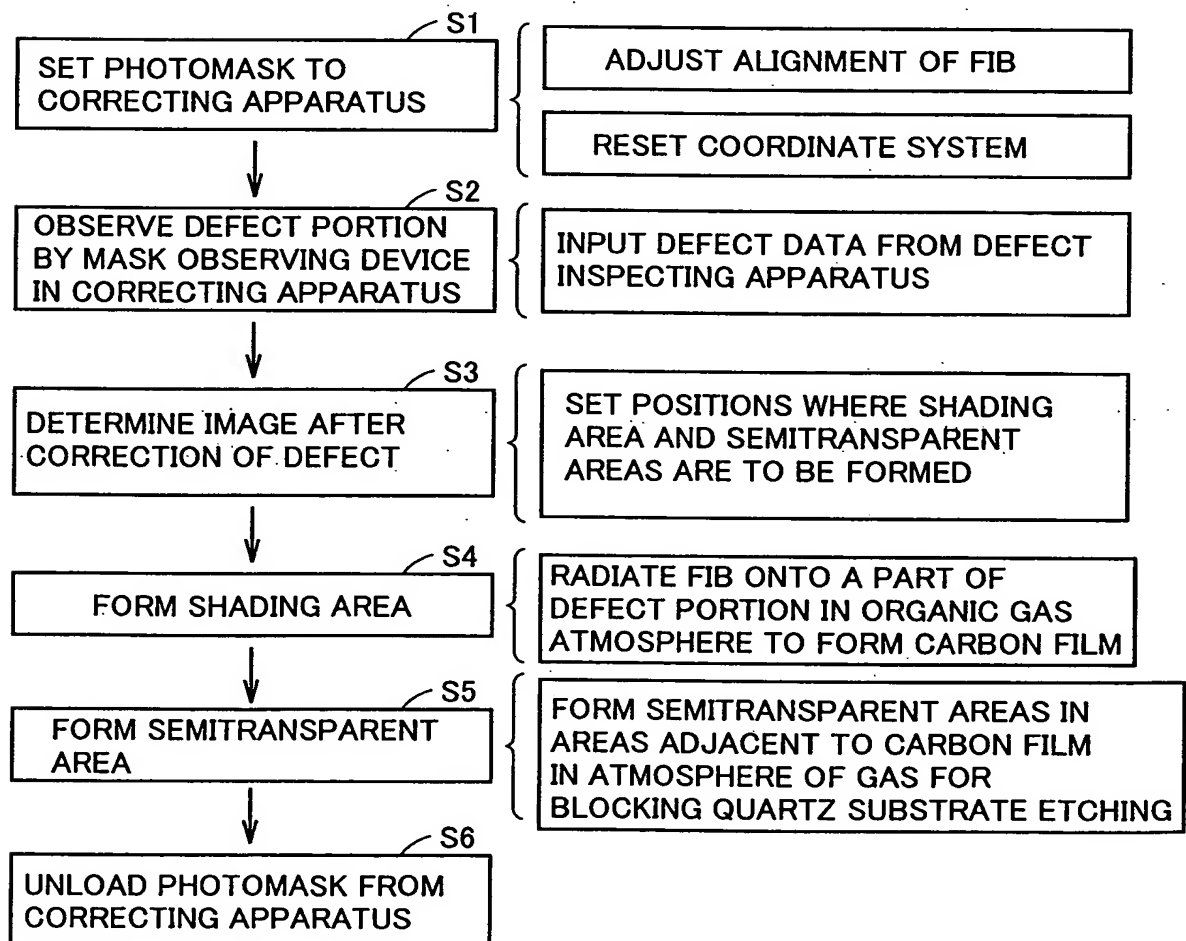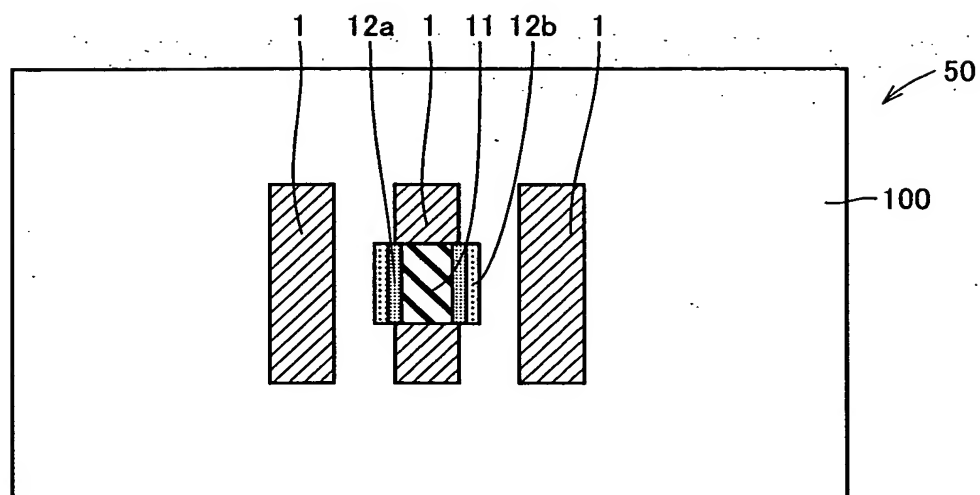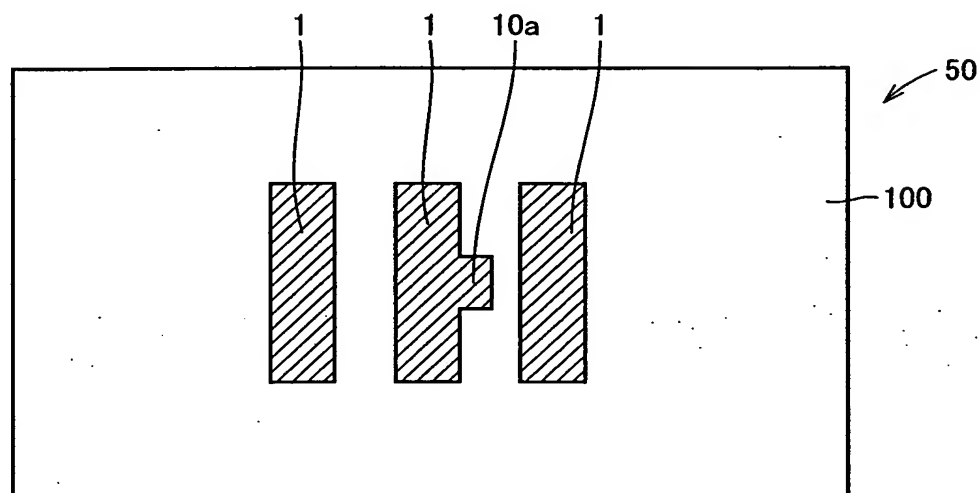FIG.28

FIG.29

FIG.30

FIG.31

FIG.32

211

212

213

202

2000

214

215

210 LASER OSCILLATOR

205 GAS SUPPLYING SECTION

204 STAGE CONTROL H/W

220

203

201

206 LOAD/UNLOAD UNIT

207 Vacuum Pump

209

CONTROL UNIT

ROM

CPU

RAM

OPERATING CONSOLE

INPUT SWITCH

208

FIG.33

ION BEAM OPTICS — 101,103,104

HIGH VOLTAGE SUPPLY

ACCELERATION

SUPPRESSOR

EXTRACTOR

FIRST LENS

SECOND LENS

DETECTOR

BLANKING AMPLIFIER

SCANNING AMPLIFIER

TO STAGE MOTOR

108,109,111,130

MOTOR DRIVE BOARD

RASTER GENERATOR BOARD

NEUTRALIZER CONTROL BOARD

VACUUM CONTROLLER

HOST COMPUTER

OPERATION INTERFACE BOARD

DEFECT INSPECTING APPARATUS SERVER

106

LOAD LOCK

X MOTOR

STAGE

NEUTRALIZER

107

Y MOTOR

130

GAS RESERVOIR

100

WORK CHAMBER

113

OPERATION PANEL 110

112

VACUUM PUMP

OBSERVING DISPLAY

MONITOR

KEY BOARD

JOYSTICK

FIG.34

WORKING FLOWCHART

S11

```
    PREPARE
   CORRECTING
  RECIPE FILES
```

↓

S12

```
OBSERVE DEFECT
```

↓

S13

```
   DESIGNATE
CORRECTION WORKING
  PORTION OF
    DEFECT
```

↓

S14

```
    START
  CORRECTION
```

↓

S15

```
    OBSERVE
DEFECT PORTION
     AFTER
  CORRECTION
```

UNACCEPTABLE

ACCEPTABLE

↓

```
END CORRECTION
```
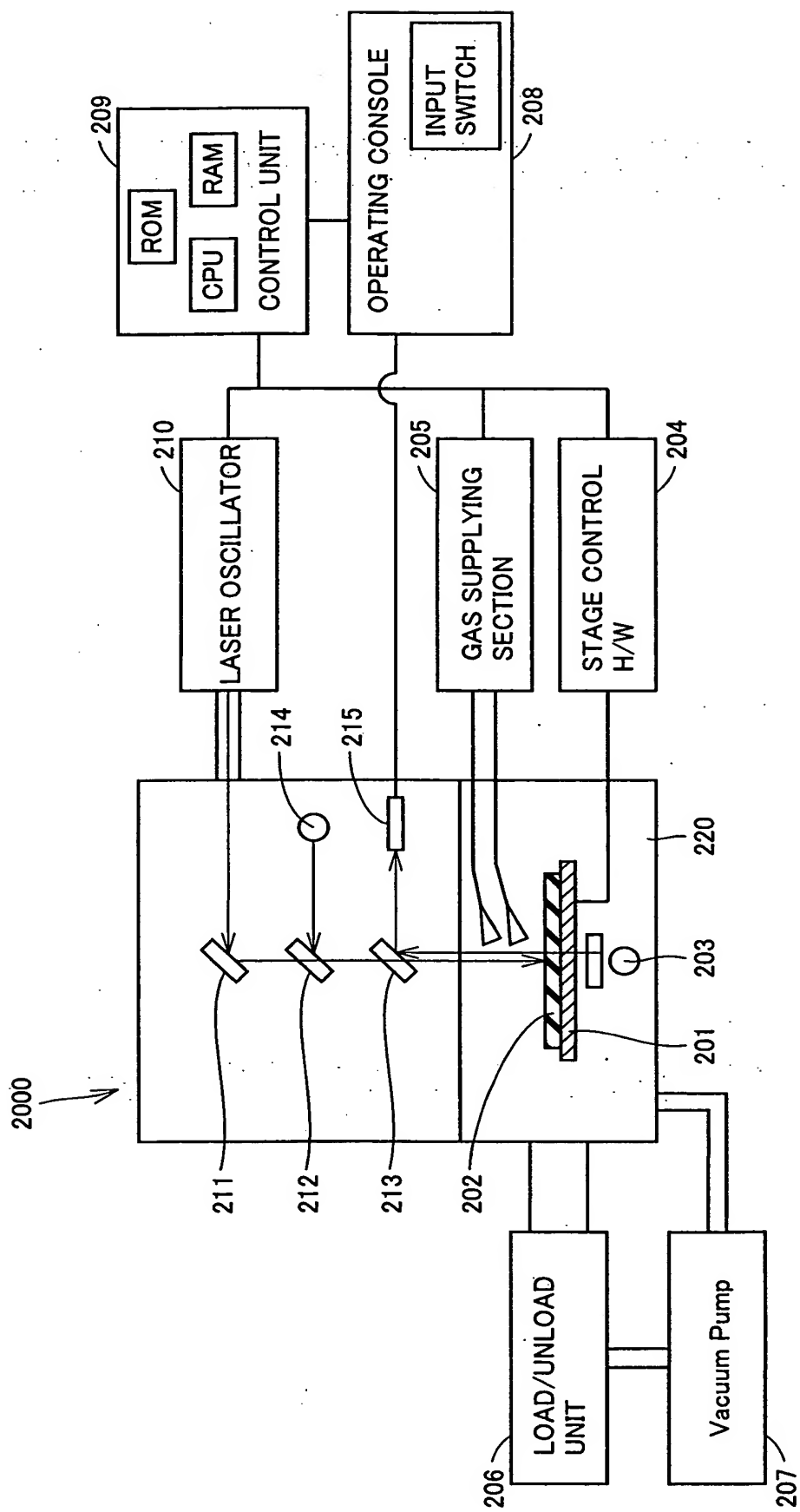
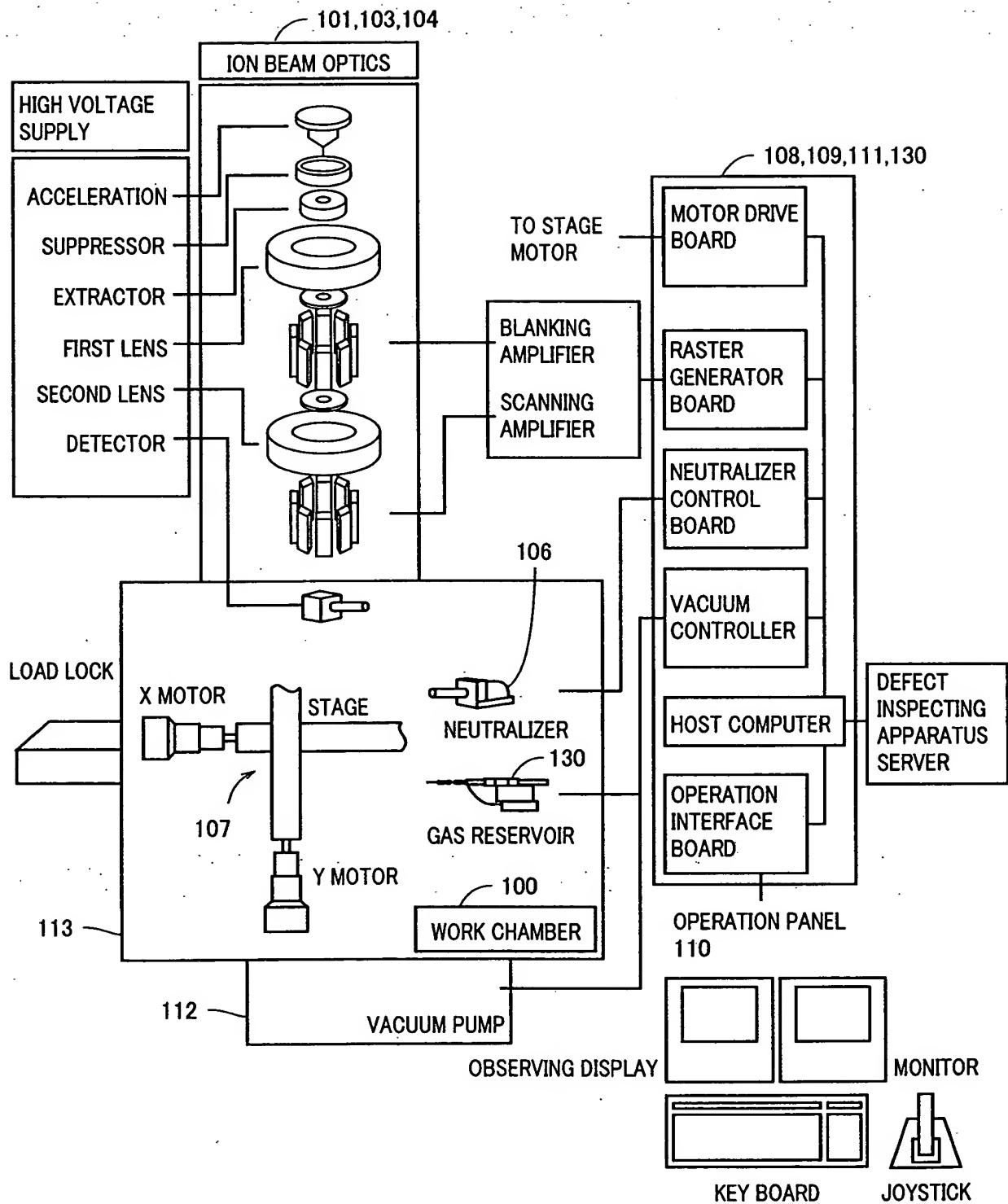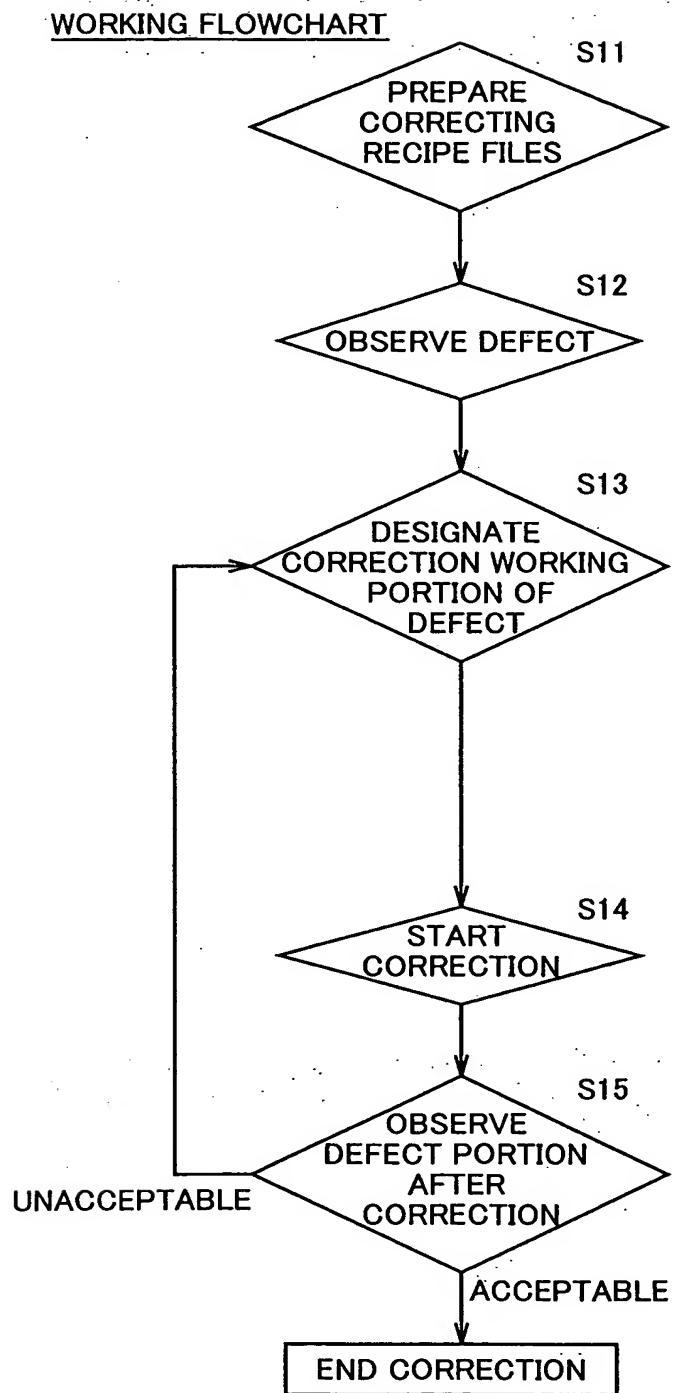# FIG.35

FLOWCHART OF MASK DEFECT
CORRECTING APPARATUS OPERATION

PROCEDURES
1.LOAD MASK
2.SELECT RECIPE
3.GAIN DEFECT COORDINATE DATA
4.MATCH COORDINATE ORIGIN
5.MATCH ALIGNMENT
6.MOVE STAGE TO DEFECT
7.SURROUND DEFECT
8.START CORRECTION
9.UNLOAD